EXTENT, CHARACTER, AND FORESTATION POSSIBILITIES OF LAND STRIPPED FOR COAL IN THE CENTRAL STATES

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Private - Ohio Reclamation Assoc.; Indiana Coal Producers Assoc.; Illinois Coal Strippers Assoc.; Missouri Coal Operators Assoc.; Southwestern Interstate Coal Operators Assoc.; Iowa Coal Institute; West Kentucky Coal Agency

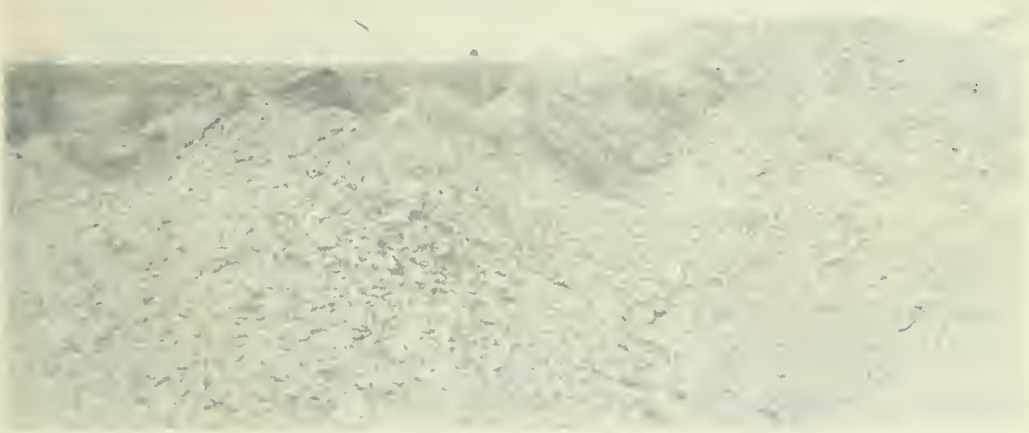

Figure 1.--Typical strip-mined land immediately after mining. Ninety-five percent of the strip-mined land in the Central States can be made productive.

Figure 2.--A reforested strip-mined area used for wood production and recreation.

C O N T E N T S

EXTENT, CHARACTER, AND FORESTATION POSSIBILITIES OF LAND STRIPPED FOR COAL IN THE CENTRAL STATES

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G. A. Limstrom

INTRODUCTION

Approximately 190,000 acres of land have been strip-mined for coal in the Central States region.[1/] By this process the coal is obtained after removing all overlying soil and rock strata. Of this strip-mined area more than 95 percent is potentially useful for timber production, agricultural crops, or recreation. Less than 5 percent is unsuited to plant growth. These estimates are based on a reconnaissance made in 1946 and 1947 to determine the region's strip-mined area and its suitability for plant growth. These survey results served as a basis for studies to determine possible uses of strip-mined land. Areas were determined from maps and aerial photographs made available by landowners and various state and federal agencies, and verified by field examination. They include the total land surface from which the coal has been removed and the unmined lands upon which the excavated material has been placed. Adjacent undisturbed land surfaces which may or may not have been affected by these mining operations are not included.

Large-scale mining of coal by open-pit methods began a short time before the first World War when the development of power equipment made feasible the recovery of coal near the earth's surface that was not minable by common underground methods. The total area that can be stripped in the future is

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1/ Includes Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Ohio, and Oklahoma.

difficult to estimate because of: (1) lack of detailed prospecting data; (2) changing social and economic conditions influencing the industry; and (3) possible technological developments that may alter the depths to which coal can be recovered by these methods.

THE EXTENT OF STRIP-MINING IN THE CENTRAL STATES

Indiana, Illinois, and Ohio have approximately equal areas of strip-mined land, and together account for about three-fifths of such land in the Central States region (fig.3). Coal has been mined by this method in 123 counties in the region, extending west from Columbiana County, Ohio, to Wilson County, Kansas; and south from Marion County, Iowa, to Atoka County, Oklahoma. These operations are especially concentrated in Crawford County, Kansas; Pike County, Indiana; and Harrison County, Ohio, where 13,784, 10,438, and 8,631 acres, respectively, have been stripped (fig. 4). These acreages represent 3.6, 4.7, and 3.2 percent of the total land area of the individual counties, but in most other counties stripped land accounts for less than one percent of the total. A larger area was strip-mined during the past decade than in any prior decade (table 1).

STRIP-MINING METHODS

Strip-mining is the process of removing a mineral deposit after first removing all overlying soil and rock strata. Various methods have been employed to move the overburden. Primitive hand picks and shovels were first used along with animal-drawn slips and scrapers. Later power equipment was used such as bulldozers, carryalls, draglines, and shovels (figs. 5 & 6). Today most operations use power shovels and draglines having dippers and scoops of 5 to 40 cubic yards capacity. The first cut, usually 50 to 100 feet in width, is made at the outcrop line on a hill, or near the property line

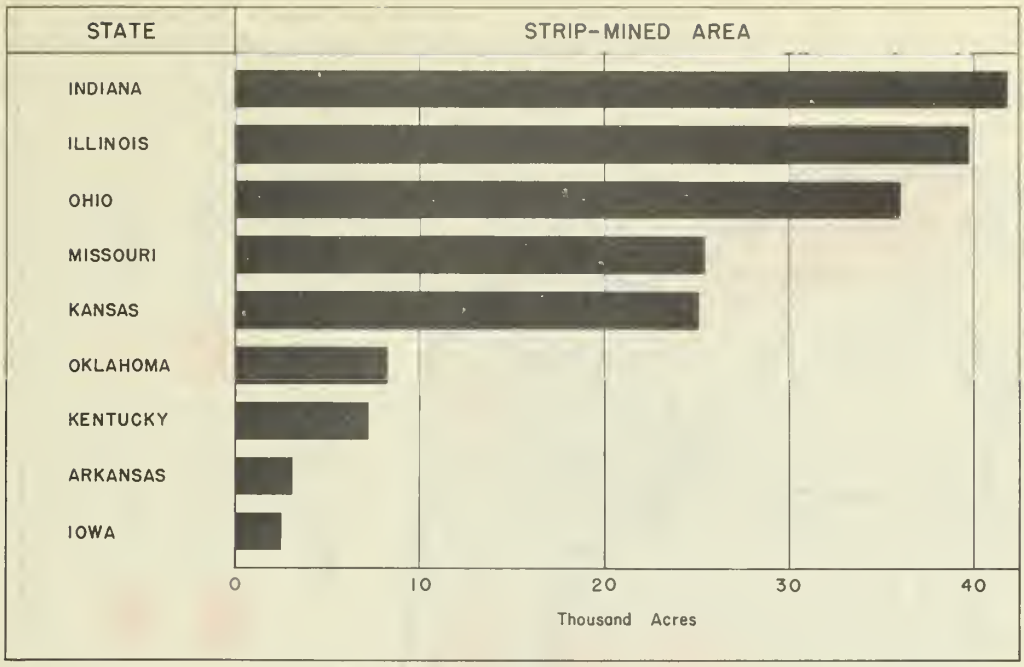
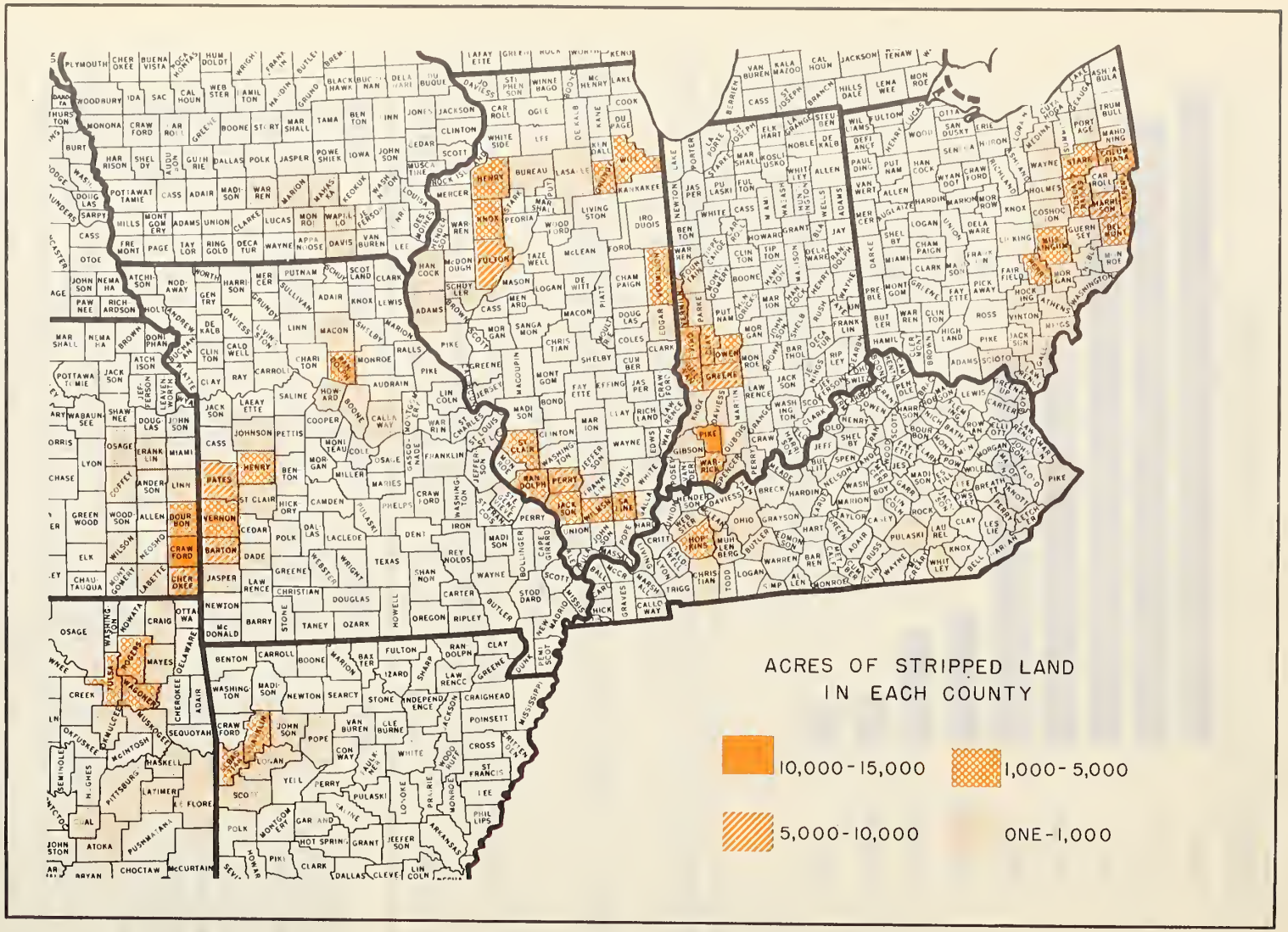


Figure 3.--Area strip-mined for coal in the Central States region, through 1946.

Table 1.--Estimated area of strip-mined land by state and age class, 1946

State	Age of stripping				Total 1/
	1 - 10 years	11 - 20 years	21 or more	Not determined	
	Acres	Acres	Acres	Acres	Acres
Arkansas	1,835	600	735	0	3,170
Illinois	18,462	8,488	982	11,888	39,820
Indiana	22,818	13,838	4,541	712	41,909
Iowa	1,747	743	9	0	2,499
Kansas	13,331	5,911	5,940	0	25,182
Kentucky	6,220	536	511	0	7,267
Missouri	9,568	9,927	5,953	48	25.496
Ohio	26,576	7,413	2,224	0	36,213
Oklahoma	4,394	1,896	2,026	0	8.316
Total	104,951	49,352	22,921	12,648	189,872

1/ The total estimated areas for each state are not strictly comparable because dates of estimates varied from October 1945 to June 1947. See tables in Appendix for dates of estimates made for each county and state.


ACRES OF STRIPPED LAND
IN EACH COUNTY
10,000 - 15,000
1,000 - 5,000
5,000 - 10,000
ONE - 1,000

on level terrain; the overlying material is placed on the side of the cut opposite the area to be mined. The coal is then removed with the use of smaller shovels and trucked to the tipple. The material moved in making the second cut is then dumped into the first. The cutting of successive strips produces a series of ridges of overturned material. The ridges or banks on different operations vary in slope and height depending on width of cut, thickness of overburden above the coal, character of rocks, and kind of equipment. The final cut leaves a depression, whose size is dependent upon the length, width, and depth of the cut. On one side is the ridge --on the other is the "high-wall" or bluff marking the edge of the final strip. Water is frequently impounded in these depressions. Where water levels are maintained above toxic materials in the adjoining high-walls, the lakes thus formed usually provide good habitats for game fish and an opportunity for recreational development.

The overburden of most coal fields is nearly always composed of two or more soil and rock strata, each of which differs from the others in hardness, texture, thickness, and chemical content. For example, in a single cut the overburden may consist of topsoil and varying thicknesses of glacial till, loess, limestone, sandstone, clay, sand, thick-bedded silty shale, and thin-bedded shale. Some of these strata are sandy in texture, some loamy, and others clayey. Many banks resulting from stripping may contain hard, massive rocks, requiring long periods to weather into soil-sized particles. Others may be so soft and poorly cemented that disintegration is rapid. Strata vary in chemical reaction; some are calcareous, some acid. Others, such as the pyritic shales, may contain enough sulphur to be toxic to plants. Hundreds of chemical analyses on many stripping operations show that many of the strata overlying coal seams are rich in mineral elements essential to plant growth. One important exception is nitrogen, which is normally added to the soil through rainfall, through the

Figure 5.--Strip-mining by power shovel methods accounts for more than 50 percent of the area stripped for coal in the Central States.

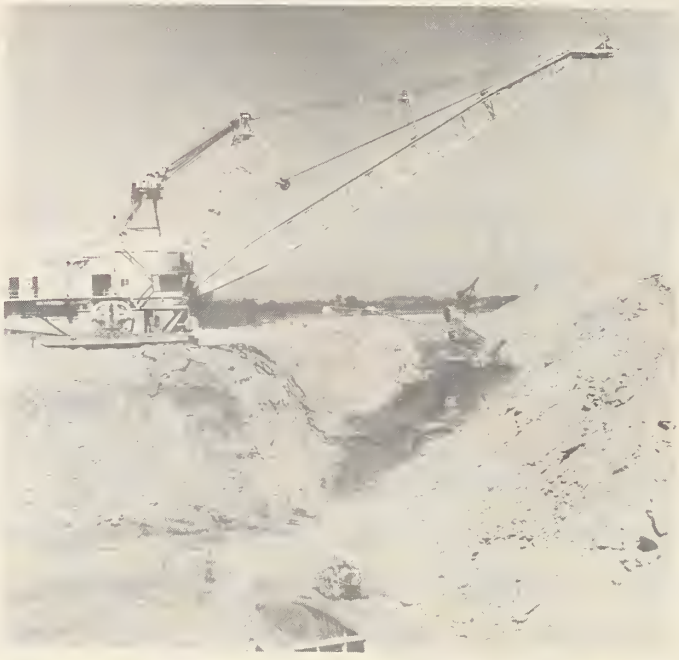


Figure 6.--Dragline methods of strip-mining are also common.

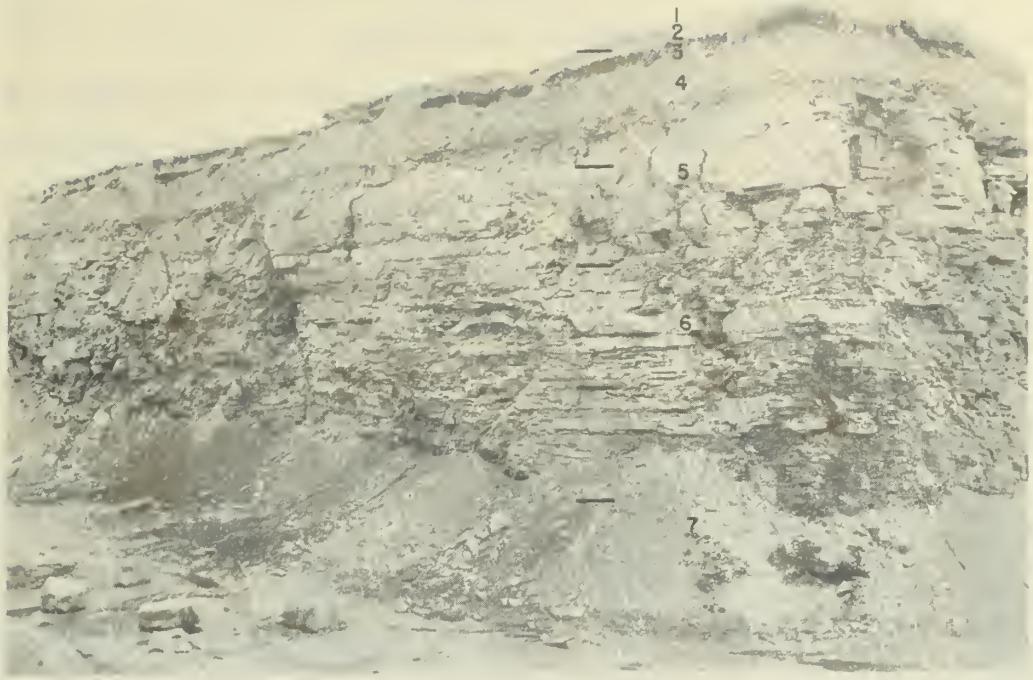


Figure 7.--Sample "high-wall", showing the diversity of strata overturned and mixed in a stripping operation for the No. 7, Upper Freeport Coal, in Columbiana County, Ohio. The vertical scale is indicated by ten-foot intervals between the black lines. The numerals in the photograph refer to strata numbers as described in the following tabulation:

Stratum number	Stratum description	Thickness (Ft.)	Acidity (pH)	Available phosphorus	Available potassium
1	Soil (Wooster loam)	0.5	6.3	Medium	Low
2	Subsoil, (brown sandy loam, with some shale and well-rounded glacial stones)	1	5.2	Medium	Low
3	Outcrop, (Mahoning coal)	1	4.7	Low	Low
4	Clay (dark gray, carbonaceous, shaly)	5	4.5	Low	Low
5	Sandstone, (grayish brown massive)	13	5.8	Medium	Low
6	Shale, (grayish to brown, silty, thin-bedded, hard, mixed with fragmental sandstone)	22	6.1	High	Low
7	Upper Freeport Coal				

nitrogen-fixing bacteria of leguminous plants, and through the action of other bacteria and fungi.

In the excavation process, materials of the overburden are mixed so that the resulting spoil surfaces often vary considerably in texture, in proportion of soil and stone, in character of rock, in acidity, and in fertility. It should therefore be recognized that strip-mined lands are more variable in composition than the surface soil of undisturbed lands.

USES OF STRIP-MINED LANDS

More than 33,000 acres of strip-mined lands have been planted to forest tree species. This acreage includes only those forest plantations that were judged to be initially successful at the time of reconnaissance. More than 18,000 acres have become adequately forested through natural seeding (fig. 8). Approximately 55,000 acres are covered with weeds, grasses, shrubs, and legumes; some of this area is used as pasture, orchard, and for other agricultural purposes. Almost one-half of the area is barren, largely because it has been recently stripped. Many strip-mined areas are being used for fishing, bathing, and other recreational purposes, such as parks, game refuges, picnic areas, and campgrounds. Some are being developed for residential purposes, and in most states, the older banks are favorite locations for berry picking.

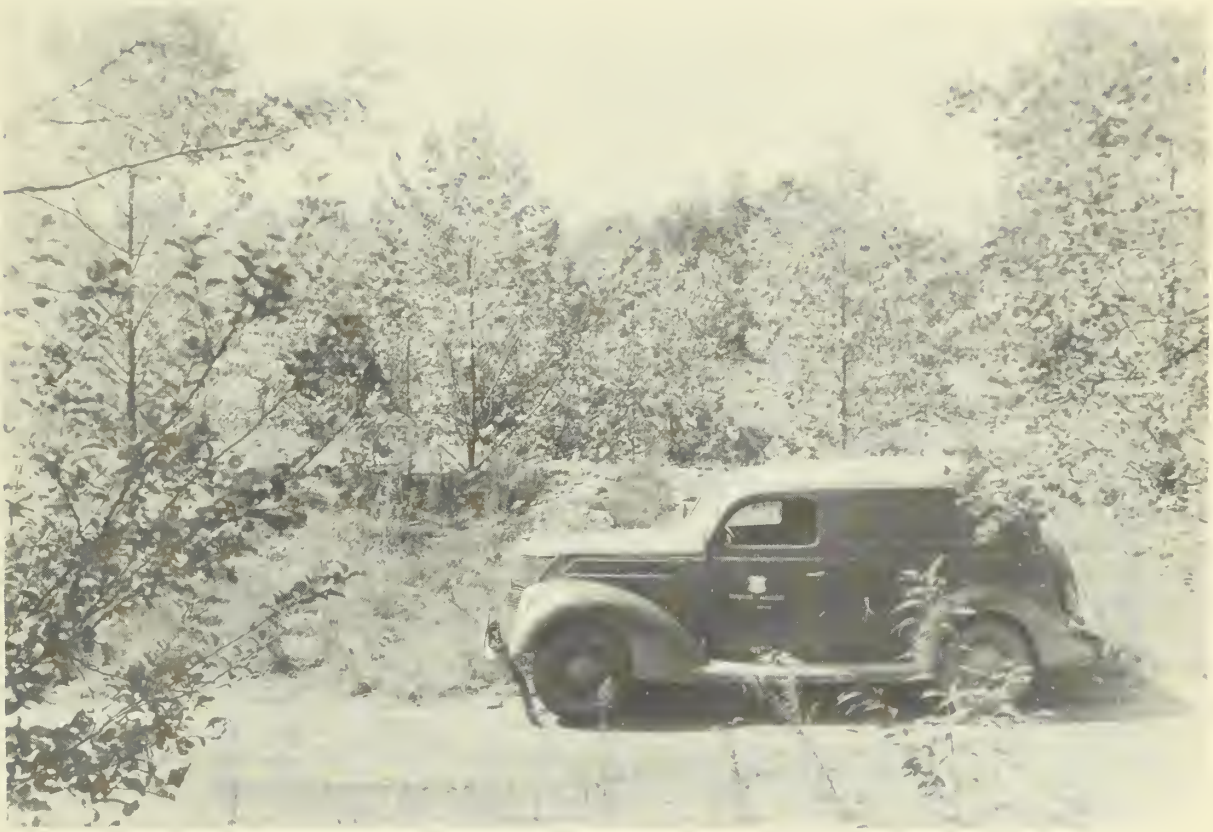


Figure 8.--Natural stand of sycamore and black locust on strip-mined lands in Jackson County, Ohio.

Table 2.--Vegetational cover of strip-mined lands

State	Barren	Herbaceous	Forest		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Arkansas	1,549	924	693	4	3,170	1947
Illinois	12,114	15,684	2,235	9,787	39,820	1946
Indiana	11,103	4,709	7,049	19,048	41,909	1947
Iowa	1,503	834	146	16	2,499	1947
Kansas	10,150	9,362	3,345	2,325	25,182	1946
Kentucky	5,924	938	384	21	7,267	1947
Missouri	11,944	10,840	2,521	191	25,496	1946
Ohio	22,654	9,744	1,710	2,105	36,213	1945-46
Oklahoma	4,782	2,759	563	212	8,316	1946
Total	81,723	55,794	18,646	33,709	189,872	--

SITE CONDITIONS ON STRIP-MINED LANDS AS THEY AFFECT FORESTATION PRACTICES

Many site conditions have a bearing on the suitability of strip-mined lands for forest planting. The most important of these are:

1. Acidity of spoils.
2. Texture of spoils, including:
   a. The general character of rocks in the overburden.
   b. The proportion of "soil" to stone.
   c. The presence or absence of glacial, loessal, and alluvial deposits.
3. Topographic conditions, such as slope, aspect, and the degree of leveling.
4. Stability, such as erodibility, slipping, and settling.
5. Character and density of vegetation.

The first two conditions -- acidity and texture -- are the most important, and can be considered the basic factors that determine plantability and the potential productivity of spoils. The other conditions have important effects on the time or "readiness" for planting, and on the choice of species and kind of stock to be used.

ACIDITY OF SPOILS

In determining the best use of strip-mined lands, the acidity of the surface material is, perhaps, the most important single site factor to consider. In considering the effect of acidity on plant behavior, three broad ranges in acidity, based on pH values, are generally recognized:

1. Toxic range, where the pH is less than 4.0. Under toxic conditions, little or no plant growth is possible. A pH of less than 3.8 is lethal to most of our common plants.

2. Acid, or "sour" range, where the pH is from 4.0 to 6.9. Many plants thrive on acid soils, but preliminary studies on strip-mined banks lead to the belief that merchantable crops of timber cannot be produced on banks with pH values from 4.0 to 4.5. Much more research is needed to determine growth possibilities of specific species in this range, and until conclusive results are obtained, it may be desirable to establish plantations for wood production on those areas where the pH values are generally above 4.5.

3. Calcareous, or "sweet" range, where the pH is 7.0 or more. Calcareous soils are suitable for the growth of a wide variety of plants.

The acidity of the surface of spoil banks varies depending upon the nature of stripping operations. In some instances the overturned strata, each differing in pH value, give a rather uniform mixture, in others a patch-wise mixture results. A bank entirely calcareous, acid, or toxic is rare indeed. In view of this fact, a practical classification of these lands for forestation requires a recognition of these varying conditions of acidity. The acidity of strip-mined lands has therefore been classified as follows:

1. Toxic Banks. These are banks having more than 75 percent of the surface area classified as toxic. Patchy areas not toxic are so small and scattered that no separate treatment is practicable. Since toxic banks are not plantable, it is fortunate that the percentage of strip-mined lands in this condition is relatively small (fig. 9).

2. Marginal Banks. Fifty to seventy-five percent of the area of these banks is toxic, the remainder being acid, calcareous, or mixed. Marginal banks may not be suitable for timber production, but

the scattered areas which are not toxic can be planted for soil improvement, erosion control, wildlife, or aesthetic purposes.

3. Acid Banks. More than 50 percent of the area of these banks is acid. Much of the strip-mined land in the region is in this class, and can be forested with a wide variety of conifers and hardwoods.

4. Calcareous Banks. More than 50 percent of the surface area is calcareous. Such banks can be planted to a large variety of hardwoods and some conifers, and include most of the strip-mined lands of agricultural value.

5. Mixed Banks. As the name indicates, these banks are so mixed that no acidity class is predominant. By definition, less than 51 percent of the area is acid, less than 51 percent calcareous, and less than 50 percent toxic. In other words, patches of toxic, acid, and calcareous areas are about equal in size, and of such proportions that the area cannot be placed in any of the foregoing classes. The reclamation of mixed banks for agricultural, forest, or aesthetic purposes should vary with the distribution of these acidity classes on each area. Forest planting should be limited to those species that are adaptable to both acid and calcareous conditions.

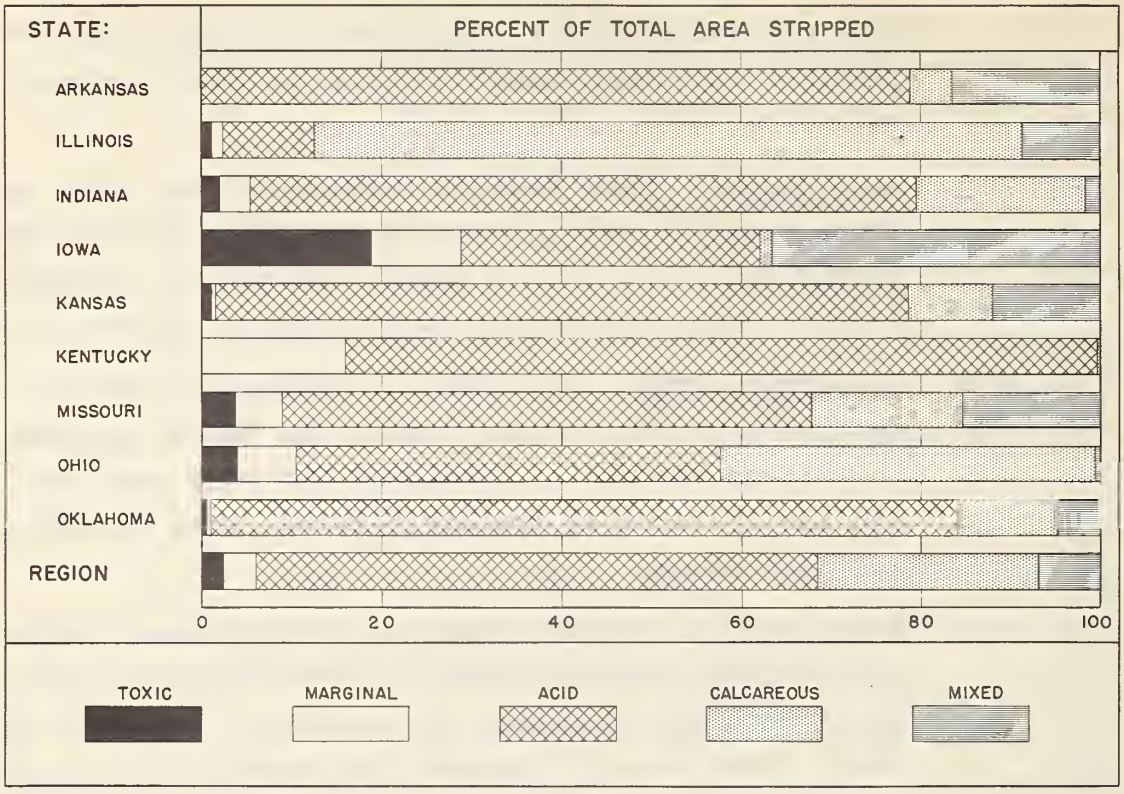


Figure 9.--Proportion of area of strip-mined land in acidity classes, 1946.

TEXTURE OF SPOIL MATERIALS

Character of Rocks

The character of materials making up the spoil surfaces has an important effect on plant growth and ultimate soil development. These materials include the sands, silts, and clays, as well as sandstone, shales, and limestones. The variation in texture, acidity, and fertility of the spoil surface depends upon the amount of different kinds of rock overturned in the stripping operation. Textural classification of strip-mined lands, therefore, cannot be so simple, exacting, and detailed as for soils, which are usually derived from relatively uniform parent material. However, certain broad textural classes of spoils are recognized and grouped as follows:

1. Sands. Sandy spoils are composed principally of sand, sandstone, and sandy shales. Small scattered areas of other rocks may sometimes be found in sandy spoils. Sandy spoils are coarse-textured, drain rapidly, and have low water-retaining capacity. They are usually low in fertility and are generally suitable only for the growing of conifers and a few drought-resistant hardwoods.

2. Loams and Silty Shales. These are spoils composed mainly of loamy material and silty shales. More than 70 percent of the area of strip-mined lands in the region was found to be in this class (table 3). These banks usually contain enough silt and clay to provide good water-retaining capacity, thereby raising the general level of fertility. The high proportion of silty shale tends to provide good aeration and drainage.

3. Clays. Clay spoils are composed largely of clay, the remaining materials being limestones, clay shales, or silt derived from loessal deposits. The clay spoils usually have high fertility and water-retaining capacity, but because of the high proportion of silt and clay are poorly drained and aerated. The impervious character of such banks tends to make them water-logged when leveled.

The Ratio of "Soil" to Stone

The proportion of soil-sized particles (2 mm. or less in diameter) in the spoil material greatly influences the success of forest plantations. The ratio of soil to stone is important in considering the choice of species for planting, because of its effect on available soil moisture, aeration, and drainage. Water-holding capacity increases and internal drainage decreases as soil percentage increases through

weathering. Initial survival and growth of plantations have been found to be directly related to this percentage of fine material in spoil surfaces. It may be the principal single criterion for determining the choice of dry-site or moist-site species.

Because of the absence of vegetation on newly formed banks, weathering proceeds mainly by two natural processes, physical disintegration and chemical decomposition. In spoil materials, physical disintegration is generally rapid during the first three to five years after stripping, and then proceeds at a very slow rate. Chemical decomposition is exceedingly slow, forming a relatively small proportion of soil each year. The determination of soil percentages made after the initial period of rapid disintegration will therefore provide a fairly reliable measurement of this site factor for a number of years.

Much more research is needed on rates of weathering in relation to the soil conditions that will ultimately prevail on a given site. Current and proposed investigations, if carried out for a number of years, aim to show soil percentage requirements for species suitable for planting on spoils as well as to ascertain proper "waiting periods" for planting on each site. Based on results obtained to date, only species adapted to dry sites will give good initial survival on banks with less than 50, 40, and 30 percent soil in the sandy, loamy, and clayey texture classes respectively.

Glacial, Loessal, Alluvial, and Other Deposits

The influence of deposits resulting from glaciers, wind, and water on the plantability of strip-mined lands is indirect, in that their effects relate chiefly to the percentage of soil, acidity, texture, and erodibility of bank surfaces. Thick mantles of glacial till, loess, and alluvium increase the proportion of soil, and thereby generally improve

Figure 10.--Soil percentage affects choice of species. Note difference in survival and height of jack pine planted on left bank with 60 percent soil and on right bank with 25 percent soil. Clay County, Indiana.

Figure 11.--Sliding action of stone and low percentage of soil make this a poor site for yellow poplar and black walnut. Saline County, Illinois.

site conditions and accordingly affect the choice of species for planting. Valley stripping usually results in more soil in spoil surfaces than hillside stripping, because of the greater proportion of alluvium in the overburden. Because of the high silt content of loess, banks having a high proportion of this material are often subject to more gullying than others. The character of glacial till is variable, but where a high proportion of gravel and stone occurs spoil surfaces are usually coarse-textured and porous with good drainage.

TOPOGRAPHY

The general effects of topography on survival and development of plantations are well known, and are essentially the same for strip-mined lands as for other lands. The general configuration of undisturbed spoils is a succession of small ridges a short distance apart, single ridges with two large slopes, or a series of conical spoil piles. Recent studies have indicated that survival and growth for some species are much better on the relatively moist lower slopes than on the tops of ridges and upper slopes (fig. 12). Important species which are adapted to moist sites include white ash, yellow poplar, black walnut, catalpa, basswood, white oak, black locust, cottonwood, and sycamore. Oftentimes some of these species, including pines, grow equally well on both lower and upper slopes. This is due to excellent moisture conditions on bank tops, made possible by the right kinds of weathered materials. More studies are needed to show conclusively which species are best to plant on given kinds of site.

Comprehensive tests to determine the survival and growth rates of trees planted on leveled strip-mined land have already been established. Continuing observations and measurements will be needed before conclusive results can be obtained. The evidence to date on all of the sites studied, indicates no beneficial effects of leveling, and further

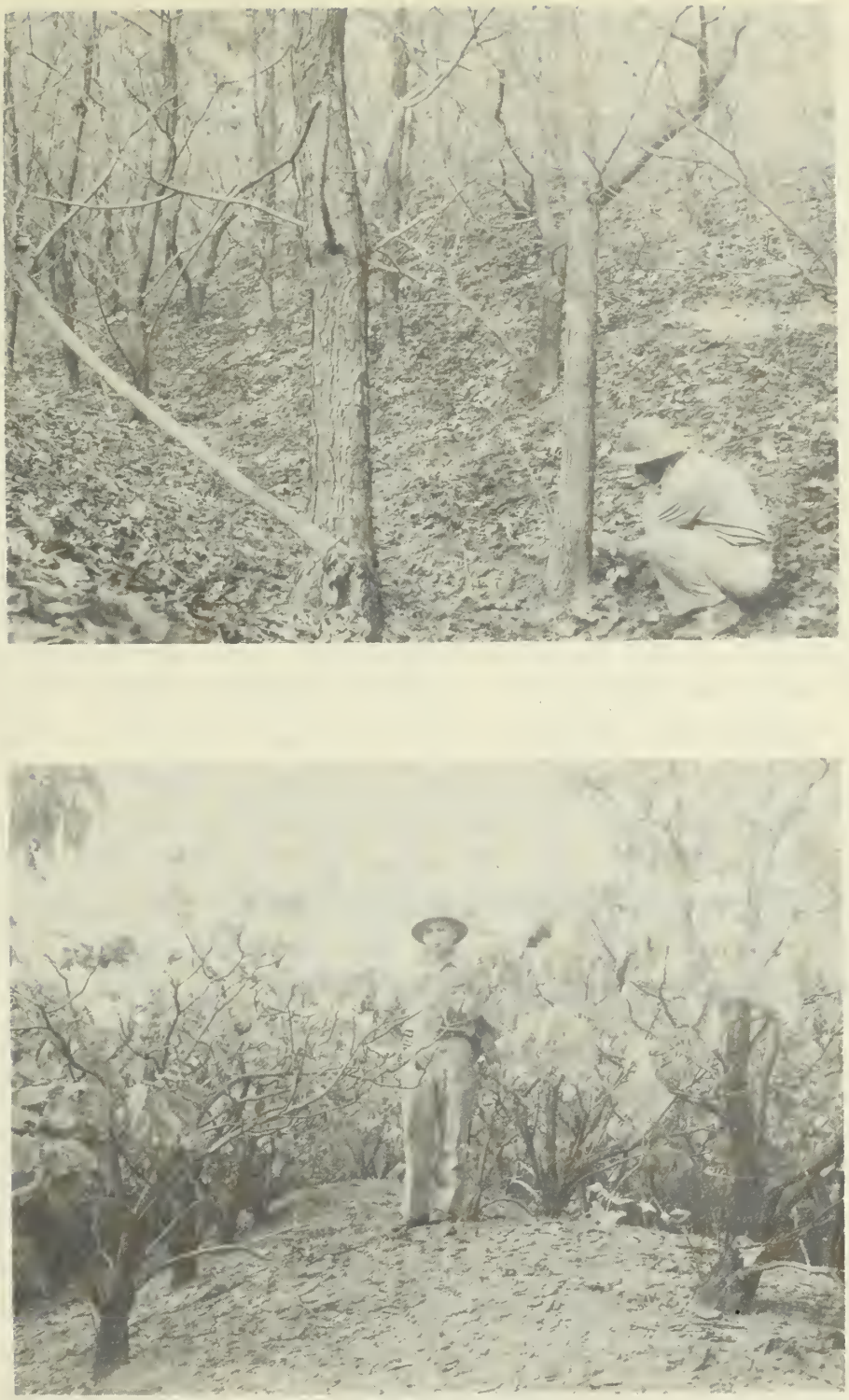


Figure 12.--Effect of topographic location on the growth of catalpa, Barton County, Missouri. A. Twelve-year old catalpa on bottom and lower slopes. B. Same plantation on ridge top.

indicates detrimental effects on the growth of trees planted on leveled banks containing a high proportion of clay. For leveled sandy banks and for leveled loamy banks with a high proportion of stone, the choice of species may be similar to that for unleveled banks of these textures. On the contrary, leveled banks with high clay content should be planted with only those species capable of tolerating compact, water-logged, and impervious soils.

STABILITY

The degree to which spoils have settled or become stable must be considered in selecting tree species for planting. Also, the time required after stripping to attain stability sufficient for planting is important. The erodibility of strip-mined lands varies considerably with the textural make-up of surface materials. Spoils composed chiefly of sand or silty loess, for example, are much more subject to gullying than loamy spoils containing a large proportion of shale. Banks which are apt to be erosive should be stabilized by planting black locust, or, where soil conditions are appropriate, by seeding to such forage species as grass and sweet clover. If a timber stand is desired, other species can be planted after the banks have been stabilized.

In stripping operations the spoils created are sometimes placed on steep hillsides exceeding 60-percent grades, or placed in steep piles with slopes greater than 70 percent. If there is a distinct cleavage between these piles and the earth beneath--often detected by the seepage of water--the entire spoil mass may slip downward. Such slipping usually occurs within a few years after the stripping operation. Therefore areas of this kind--including the area below the stripping--should not be planted until at least five years after mining.

Occasionally banks are composed almost entirely of loose flaky shale or large stones, and have little or no soil. These loose materials are continually sloughing or sliding downward. Because of the low soil percentage and the cutting action of sliding stone, such sites are poor planting chances. They should be left unplanted until the banks become reasonably stable.

GROUND COVER

The character and density of vegetation on strip-mined lands have considerable influence on the initial survival and growth of planted trees. The detrimental effects are due mainly to shading and excessive moisture loss. The relative importance of these effects varies according to local climate and kind of bank. On strip-mined areas west of the Mississippi River, where extreme drought in late summer is of common occurrence, soil moisture may be the limiting factor. On these areas the use of well-balanced planting stock is especially important. Banks supporting heavy sod or dense growth of legumes and weeds should, perhaps, be scalped at the time of planting, that is, all vegetation should be removed within a radius of approximately one foot from each planted tree. Well-balanced hardwood stock with 10- to 12-inch tops is recommended for such planting areas.

East of the Mississippi, rainfall is usually well distributed throughout the year. Consequently a dense growth of weeds and grasses develop on some banks. Small planting stock on these situations often sustain severe losses due to overtopping. For areas of this kind planting of large one-year-old hardwood stock will also give best results.

Some owners may wish to underplant strip-mined areas having brushy covers or having scattered trees of poor quality or undesirable species. Large stock of such species as yellow poplar, white ash, white oak, bur oak, hard maple, and basswood

Figure 13.--Where ground cover is dense, survival and development of pine plantations is usually poor. Jackson County, Illinois.

Figure 14.--Effect of spoil bank leveling on growth of silver maple. Area in foreground has been leveled, bank in background has been left undisturbed. Both areas planted at the same time. Fulton County, Illinois.

should be used on these areas. Planting of pine in such areas will usually fail unless the overtopping vegetation is continually removed (Fig. 13).

BASIC SPOIL TYPE

The two site factors of greatest importance--acidity and texture--are combined to form the basic spoil types (table 3). More than 104 thousand acres, or 55 percent of the spoil area in the region, is made up of acid loams and silty shales (spoil type 3-B). Similarly, 26 thousand acres, or 14 percent is calcareous clay (spoil type 4-C). Recommendations for forest planting on spoil banks, given later in this paper, are based on the basic spoil types shown in table 3.

Table 3.--Area of strip-mined land in the Central States Region[1/] by acidity and texture classes

Acidity class	A. Sands		B. Loams and silty shales		C. Clays		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	1,067	0.6	2,156	1.1	1,128	0.6	4,351	2.3
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	1,525	0.8	4,429	2.3	1,126	0.6	7,080	3.7
3 Acid. More than 50% with pH of 4.0-6.9	4,216	2.2	104,446	55.0	9,692	5.1	118,354	62.4
4 Calcareous. More than 50% with pH of 7.0 or higher	1,754	0.9	18,586	9.7	26,488	14.0	46,828	24.6
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	2,154	1.1	8,355	4.4	2,750	1.4	13,259	7.0
Total	10,716	5.7	137,972	72.6	41,184	21.7	189,872	100.0

1/ Includes Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Ohio, Oklahoma

FOREST PLANTING RECOMMENDATIONS

Before planting, the landowner should consider the species adaptable to the proposed planting area. He will also want to decide upon the main purpose of his planting. In establishing forest plantations on spoil banks, the owner must carefully consider the following factors: (1) choice of species; (2) season for planting; (3) spacing; (4) mixed planting; (5) care of stock and methods of planting; (6) care of plantations; (7) direct seeding; (8) exotic species.

CHOICE OF SPECIES

The species suitable for various kinds of planting sites are given in the tentative planting guide (pp. 35-39). The species recommended for an area are usually native to it, or are not too far removed from their natural range. A few species, particularly conifers, have been successfully planted far from their usual geographical ranges. Shortleaf pine plantations have been severely damaged by winterkilling when planted north of its natural range. In general, it is probably safer to plant northern pines farther south and eastern pines farther west of their natural range than it is to plant southern pines to the north of their native habitat. Some exotic species give promise for the production of certain small forest products -- Christmas trees, pulpwood, and posts --but data are insufficient for specific recommendations.

The recommendations in the planting guide are tentative, but should prove useful until further research determines the adaptability of species to the many conditions prevailing on strip-mined lands. They are, however, based on all studies and observations to the present time, and should help to reduce the number of plantation failures due to improper species selection for a given site. Conifers and hardwoods are listed separately in the planting guide, and the species in each group are given in the order of preference.

In the choice of species, consideration should be given to the main purpose of the planting. Some of the objectives of forestation on strip-mined lands are:

1. Soil improvement and erosion control.--Because black locust has proved superior to other species for erosion control, no other species is listed for this purpose. It is, moreover, one of the best species for soil improvement, since bacteria associated with its roots add nitrogen to the soil. Because nitrogen is an element deficient in most spoils, and necessary for plant growth this factor is important. If tree planting is not desired on a given area, some grasses and legumes can often be seeded.

2. Wildlife, recreational, and aesthetic planting.--Although the planting guide was designed mainly for plantings to produce wood, the species recommended can be used in plantings for recreation, landscape beautification, and the creation of wildlife habitats. Many other species can provide food for game birds and mammals, but they have not been listed because they have not been planted widely enough to warrant specific recommendations.

3. Wood production.--The following species can be planted on strip-mined lands in the Central States for the production of wood products. The species are listed in order of preference for each use.

   Mine props - black locust, oak, ash, red elm, sycamore, other hardwoods, and pines. In the selection of black locust for wood production, great care should be taken to determine the possibility of trees reaching merchantable size before being damaged by the locust borer. The only known means by

which this can be determined is by examination of existing black locust stands on areas in the same locality having site conditions similar to the area to be planted. Very few plantations of this species in Indiana and Illinois have reached merchantable size without some damage by the borer. On the other hand, most plantations of black locust on strip-mined lands in Missouri, Kansas, and Oklahoma have escaped injury, and are yielding substantial quantities of fence posts in eight to ten years.

Fence posts - black locust, red cedar, Osage orange, catalpa, and pines.

Christmas trees - red, jack, white, Scotch, and Virginia pines; Norway spruce, and red cedar.

Pulpwood - cottonwood, soft maple, pines.

Lumber, handle stock, etc. - yellow poplar, black walnut, pine, white ash, green ash, red gum, oaks, sycamore, black cherry, Osage orange, red elm, cottonwood, maple, basswood, red cedar.

SEASON FOR PLANTING

Spring planting, preferably before new growth starts, is recommended. Fall plantings in this region, unless protected by tall grasses or weeds, are frequently subject to damage from winterkilling and frost-heaving. On spoils with considerable silt and clay, the losses from frost-heaving are often excessive. On sandy or loamy spoils, especially if well-balanced stock is used, fall planting may be successful. The use of tall, spindly, top-heavy coniferous stock, especially, should be avoided. From the standpoint of work-load distribution, some fall planting may be desirable.

Figure 15.--Red oak plantation, eight years old, on outer bank consisting mainly of glacial till and loess, neutral to slightly acid, 90 percent soil. Saline County, Illinois

SPACING

The proper spacing for plantations is still a controversial issue on undisturbed land as well as on strip-mined land. There is probably no fixed spacing that is ideal for all species under all conditions and for all purposes. For planting on spoils where wood production is the main objective, a spacing of 7 by 7 feet appears to be about the most practicable. This spacing gives the horizontal distance between trees, not the slope distance, and results in about 890 trees per acre. Where the planting is made chiefly for aesthetic purposes or for growing Christmas trees, closer spacing of slow-growing species such as pine and red cedar may be advisable. The 6- by 6-foot and 5- by 5-foot spacings require 1,200 and 1,750 trees per acre, respectively. Close spacing may also be desired if erosion control is the chief purpose for the planting. An 8- by 8-foot spacing may suffice for those species that do not develop a branchy form at an early age when planted at wide spacings, especially where replanting of failed spots is planned. Wide spacings, such as 8 by 8 feet may also be satisfactory on exceptionally good sites, such as those banks containing a high proportion of soil to stone, and having a pH range between 6.0 and 8.0.

MIXED PLANTING

In general, mixed plantings of several species are more desirable than pure plantings of one species, because of the greater protection from insect and disease attacks, and the benefits of site improvement. Furthermore, if the season of planting is less favorable to one species than to another, mixed stands offer less likelihood of complete failure. In mixed stands containing black locust, the growth of the other hardwoods is greatly stimulated. This increased growth rate is so outstanding that mixed plantings including black locust are recommended. Species other than locust should be tolerant

to the locust shade. Mixing conifers with locust is not generally recommended unless mixed by groups. The diagram below suggests several arrangements for the mixed planting of black locust, with other hardwoods. Each "L" represents one planted black locust; each "O" represents one planted tree of other hardwoods.

75% Black Locust, 25% Other Hardwoods

```
L  L  L  O  L  L  L
L  O  L  L  L  O  L
L  L  L  O  L  L  L
L  O  L  L  L  O  L
L  L  L  O  L  L  L
```

50% Black Locust, 50% Other Hardwoods

```
O  L  O  L  O  L  O        L  O  L  O  L  O  L
O  L  O  L  O  L  O        O  L  O  L  O  L  O
O  L  O  L  O  L  O   or   L  O  L  O  L  O  L
O  L  O  L  O  L  O        O  L  O  L  O  L  O
O  L  O  L  O  L  O        L  O  L  O  L  O  L
```

25% Black Locust, 75% Other Hardwoods

```
O  L  O  O  O  L  O
O  O  O  L  O  O  O
O  L  O  O  O  L  O
O  O  O  L  O  O  O
O  L  O  O  O  L  O
```

Hardwood plantings should contain 50 to 75 percent black locust. The species can be planted alternately within each row or in alternate rows. In a 75-percent mixture, three rows of black locust can be alternated with a single row of the other hardwoods or can be mixed in the row. In mixed plantings the species can be changed with varying site conditions. For example, in a mixture of black locust with chestnut oak and yellow poplar, the latter species can be planted in the bottoms or on lower slopes and the oaks planted on the ridge tops and upper slopes.

In planting mixed conifers the species should ordinarily be grouped wherever growth rates and light tolerances of

the mixed species are different. Not less than three rows of one species should be alternated with not less than three rows of another conifer. For Christmas tree planting, however, random mixtures are satisfactory and easier to handle in the planting operation. Random mixtures are also satisfactory where selective thinnings and other intermediate cuttings are planned. Alternate rows of conifers in mixed plantings are not generally considered good practice and should be avoided.

CARE OF STOCK AND METHODS OF PLANTING

Rules to be followed in the care of stock are generally the same in planting strip-mined lands as for general reforestation practice. Because improper handling of stock has resulted in many plantation failures, the importance of proper care of trees before planting is emphasized. Roots of trees should be protected from drying, exposure to direct sunlight, or heating in tightly packed bales for long periods. Extreme care of planting stock is a "must" from the time the trees are lifted in the nursery until planted in the field.

Two generally used methods of planting are recommended for forestation of strip-mined lands, the bar-slit method, and the side-hole method, using grub hoes or mattocks.

More general use of the bar-slit method, where it is adaptable, will materially reduce planting costs. On favorable sites a trained crew will usually plant one-and-one-half to two times as many trees per day as by the mattock or hoe methods. The bar-slit method is applicable to those spoils where the bar can be thrust easily into the bank with little or no foot pressure, and where the resulting slit can be completely closed after planting by another thrust of the bar. The method is applicable to most of the sandy and loamy spoils containing a large proportion of shale. It is not applicable to heavy clay spoils nor to stony spoils.

Where the bar-slit method of planting is not practicable, the side-hole method using long-bladed grub hoes or

mattocks should be used. Tests conducted on strip-mined areas have shown these two methods to have a survival and development rate equal to those of slower and more costly methods.

CARE OF PLANTATIONS

Most plantations need some care and protection during the period of their development. During the first two years after establishment some may need release from overtopping vegetation, and all should be examined periodically to determine the need for release and to note any damage from diseases or insects. Protection from fire and grazing by livestock is also necessary.

DIRECT SEEDING

Successful establishment of trees by direct seeding on stripped lands has been limited so far to heavy-seeded species such as black walnut and oaks. Current tests are showing that the direct seeding of light-seeded species results in considerable loss from erosion. The most promising species for direct seeding appear to be black walnut, and bur, red, and chestnut oaks.

EXOTIC SPECIES

Although not recommended for general use, some landowners may wish to use Scotch pine for Christmas trees. This species can, in general, be planted on those sites where jack pine is recommended. Ailanthus may occasionally be planted for pulpwood production. It spreads rapidly by natural regeneration and may be difficult to eradicate from areas it has invaded. Some natural stands of this species have been observed on strip-mined lands, and it has been found well suited to all nontoxic sites. Good growth can be expected if planted on the loamy or clayey spoils.

The European and Japanese larches have made good growth on strip-mined lands in Pennsylvania and Indiana. Too little is known of the site requirements of these species to make definite recommendations, but both appear well adapted to sites having a pH between 5.0 and 7.5, even on poorly drained situations.

Figure 16.--Green ash plantation, nine years old, average height 15-20 feet. Seventy percent soil, 20 percent calcareous shale, 10 percent sandy shale. Knox County, Illinois.

THE TENTATIVE PLANTING GUIDE

The tentative planting guide that follows recommends tree species for planting on the principal spoil types. Part I recommends species for planting on sandy spoils in the various acidity classes. Parts II and III recommend species for the loamy and clayey spoils respectively. Part IV enumerates special conditions not occurring generally on strip-mined lands, but which need consideration where they do exist.

PART I--TENTATIVE PLANTING GUIDE

This part of the tentative planting guide suggests species for reforestation of strip-mined lands in the Central States that are predominantly sandy, with or without sandstone and sandy shales, and with lesser proportions of silty shales, limestone, silt, or clay.

Acidity class	Species recommended for planting (Restricted to areas within or near natural range)	
	0-50% soil on spoil surface	51-100% soil on spoil surface
Acid More than 50% of area with pH of 4.0 - 6.9	Jack, red, shortleaf, Virginia pines Mixtures with black locust: chestnut oak, bur oak, cottonwood, green ash	Jack, red, white, shortleaf, Virginia, pitch pines Mixtures with black locust: bur oak, red oak, white and green ash, chestnut oak, cottonwood, sycamore, silver maple
Calcareous More than 50% of area with pH of 7.0 or higher	Red cedar, jack, red pines Mixtures with black locust: cottonwood, sycamore	Red cedar, jack, red, white, pitch pines Mixtures with black locust: bur oak, cottonwood, white and green ash, sycamore, red gum, red elm, silver maple, yellow poplar
Mixed Areas with patches of varying acidity--see text, pg. 13	Group mixtures: red cedar, jack, red, shortleaf pines Mixtures with black locust: chestnut oak, bur oak, cottonwood, green ash, sycamore	Group mixtures: red cedar, red, jack, shortleaf, pitch pines Mixtures with black locust: chestnut oak, bur oak, cottonwood, sycamore, red gum, silver maple, yellow poplar

See Part IV for special conditions not applicable to all strip-mined lands, but which affect planting recommendations where they occur.

PART II--TENTATIVE PLANTING GUIDE

This part of the tentative planting guide suggests species for reforestation of strip-mined lands in the Central States that are predominantly loamy with a greater proportion of silty shales, and with lesser proportions of sandstone, limestone and clay.

Acidity class	Species recommended for planting (Restricted to areas within or near natural range)	
	0-40% soil on spoil surface	41-100% soil on spoil surface
Acid More than 50% of area with pH of 4.0-6.9	Jack, red, shortleaf, Virginia, pitch, ponderosa pines	Jack, white, shortleaf, Virginia, pitch, loblolly, red, ponderosa pines
	Mixtures with black locust: chestnut oak, cottonwood, sycamore, bur oak, green ash	Mixtures with black locust: cottonwood, sycamore, yellow poplar, black walnut, red gum, red oak, white ash, green ash, silver maple, white oak, Osage orange, basswood (linden), hard (sugar) maple, black cherry
Calcareous More than 50% of area with pH of 7.0 or higher	Red cedar, red, Virginia, pitch pines	Red cedar, white, red, pitch, loblolly, ponderosa pines
	Mixtures with black locust: cottonwood, sycamore, red oak, bur oak, green ash	Mixtures with black locust: yellow poplar, black walnut, cottonwood, sycamore, red gum, red oak, white ash, green ash, silver maple, white oak, Osage orange, basswood (linden), hard (sugar) maple, black cherry, red elm, rock elm
Mixed Areas with patches of varying acidity--see text, pg. 13	Group mixtures: Jack pine, red cedar, red, shortleaf, Virginia, pitch, ponderosa pines	Group mixtures: red cedar, white, red, shortleaf, pitch, loblolly, jack, ponderosa pines
	Mixtures with black locust: chestnut oak, cottonwood, sycamore, red oak, bur oak, green ash	Mixtures with black locust: yellow poplar, black walnut, cottonwood, sycamore, red gum, red oak, white ash, white oak, Osage orange, basswood (linden), hard (sugar) maple, black cherry, red elm, rock elm, green ash, silver maple

See Part IV for special conditions not applicable to all strip-mined lands, but which affect planting recommendations where they occur.

PART III--TENTATIVE PLANTING GUIDE

This part of the tentative planting guide suggests species for reforestation of strip-mined lands in the Central States that are composed predominantly of clay or silt, with or without limestone and clay shales, and with lesser amounts of sand, sandstone and silty shales.

Acidity class	Species recommended for planting (Restricted to areas within or near natural range)	
	0-30% soil on spoil surface	31-100% soil on spoil surface
Acid More than 50% of area with pH of 4.0-6.9	White, loblolly, pitch, ponderosa pines Mixtures with black locust: cottonwood, sycamore, red oak, red gum, chestnut oak, bur oak, green ash	Mixtures with black locust: cottonwood, sycamore, yellow poplar, black walnut, red gum, white ash, green ash, silver maple, hard (sugar) maple, basswood (linden), white oak, Osage orange, red elm, rock elm
Calcareous More than 50% of area with pH of 7.0 or higher	Red cedar, white pine Mixtures with black locust: cottonwood, sycamore, red oak, red gum, bur oak, green ash	Mixtures with black locust: cottonwood, sycamore, yellow poplar, black walnut, red gum, white ash, green ash, silver maple, hard (sugar) maple, basswood (linden), white oak, Osage orange, black cherry, red elm, rock elm
Mixed Areas with patches of varying acidity--see text, pg. 13	Group mixtures: red cedar, white pine Mixtures with black locust: cottonwood, sycamore, red oak, red gum, chestnut oak, bur oak, green ash	Mixtures with black locust: cottonwood, sycamore, yellow poplar, black walnut, red gum, white ash, green ash, silver maple, hard (sugar) maple, basswood (linden), white oak, Osage orange, black cherry, red elm, rock elm

See Part IV for special conditions not applicable to all strip-mined lands, but which affect planting recommendations where they occur.

PART IV--TENTATIVE PLANTING GUIDE

This part of the tentative planting guide discusses special conditions not occurring generally on strip-mined lands, but which need consideration where they do exist.

1. Toxic areas. A few banks may have more than 75 percent of the surface area with a pH of 4.0 or less; this means that less than 25 percent of the area is not toxic, but these areas are usually so small and scattered that the entire bank should be considered nonplantable.

2. Marginal areas. These are banks where 50 - 75 percent of the surface area is toxic; the toxic areas are not plantable, but the remainder may be planted according to its classification as given in Parts I, II, and III. Such areas may not be suitable for timber production in their present condition, but planting for erosion control, soil improvement, wildlife, and aesthetic purposes is desirable.

3. Areas subject to severe gully erosion. For these areas planting of black locust, either pure or with small percentages of other hardwoods, is recommended. Where merchantable stands of black locust are not obtainable, underplanting with other hardwoods may be desirable, after spoil surfaces have been stabilized.

4. Leveled and partially leveled areas. For areas that have been leveled use the same species as recommended in Parts I, II, and III, where sites are in the sandy and loamy categories. If the area has a high proportion of clay, with little or no sandstone and shale, restrict species to white ash, green ash, black locust, sycamore, hard maple.

5. Areas subject to slipping and sliding. These are areas where spoils have been placed on original slopes with greater than 60 percent grades, or spoils which are piled in ridges having more than 70 percent grades. Slipping and sliding usually occur within a few years after stripping. Areas where this may occur should not be planted until five years after stripping.

6. Areas with dense ground cover. These are areas having a dense cover of legumes, grasses, and weeds. On these areas use the best grades of planting stock; for most species this means large, well-balanced seedlings or transplants. For areas of this kind west of the Mississippi River, it may be desirable to "scalp" spots two feet square before planting each tree. Large, well-balanced hardwoods are especially adapted to these sites.

7. Cedar-apple rust. Red cedar should not be planted within one mile of existing apple or pear orchards; these species are subject to a serious disease if growing in close proximity to red cedar. Some states have laws pertaining to the planting of red cedar and apple trees on contiguous areas, and these should be investigated before planting of red cedar is undertaken.

RESEARCH NEEDS

The recommendations contained in this publication should be regarded as general and tentative, since the completion of current and proposed investigations may reveal solutions to many problems relating to the reclamation of strip-mined lands. In addition to continuing studies in the adaptation of species to the varied site conditions, the following specific problems need further research:

1. Effects of leveling on growth and survival of forest plantations.
2. The effects of mixed plantings and the role of black locust as a nurse crop.
3. The range of acidity toxic to different tree species, the effects of acidity on the productivity of spoil materials, and methods of reducing the area of toxic spoils.
4. Rate of weathering for each of the many kinds of spoil materials occurring on strip-mined areas, and the age of spoils before planting should be undertaken.
5. Specifications of planting stock to meet the demands of each major spoil type.
6. Seeding studies to explore the possibilities of reducing reforestation costs by direct seeding.
7. Care of plantations, such as release cuttings, thinnings, pruning, and harvesting.

SUPPLEMENTARY PUBLICATIONS

In addition to this publication dealing with regional conditions and general classification of strip-mined lands, separate papers are being prepared showing in detail the character of strip-mined areas in each of the states in the

region. Maps showing the location of coal-bearing formations and strip-mined areas by spoil types are also being prepared for some of the states. (See sample in Appendix, pg. 44).

As solutions to the problems listed in "Research Needs" are found the information will be released as technical papers or through other publication media.

SUGGESTED READING

Chapman, A. G.
1935. The effects of black locust on associated species with special reference to forest trees. Ecol. Monog. 5: 37-60, illus., reprint.

1944. Forest planting on strip-mined coal lands with special reference to Ohio. Central States Forest Experiment Station Technical Paper No. 104, 25 pp. (Multilithed).

1947. Rehabilitation of areas stripped for coal. Central States Forest Experiment Station Technical Paper No. 108, 13 pp. (Multilithed).

1948. Survival and growth of various grades of shortleaf pine planting stock. Iowa State Journal of Science, 22: no. 4, 323-331.

Griswald, N. B., and McKnight, J. S.
1947. Wood use by Alabama mines. Southern Forest Experiment Station Occasional Paper No. 109, 12 pp. (Multilithed).

Minckler, Leon S., and Chapman, Arthur G.
1948. Tree planting in the Central, Piedmont and Southern Appalachian regions. Farmers' Bulletin No. 1994, U. S. Dept. Agr.

Moore, H. R., and Headington, R. C.
1940. Agriculture and land use as affected by strip-mining of coal in eastern Ohio. Bulletin No. 135, Dept. of Rural Economics and Rural Sociology, Ohio Agr. Exp. Sta. (Mimeographed).

Sand, Norbert H., Bryan, Milton M., et al.
1947. Managing the small forest. Farmers' Bulletin No. 1989, U. S. Dept. of Agr.

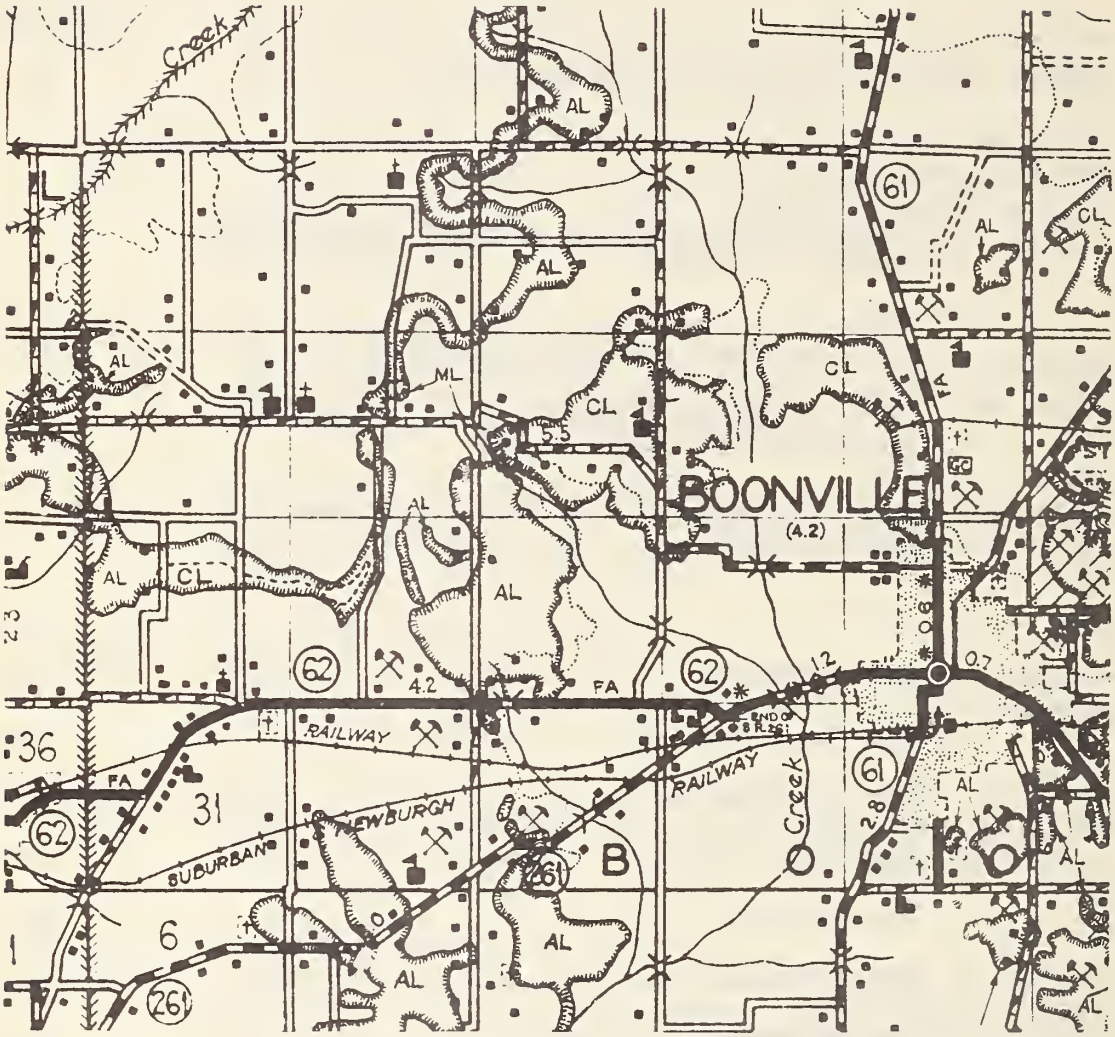
Tyner, Edward H., and Smith, Richard M.
1945. The reclamation of the strip-mined coal lands of West Virginia with forage species. Proc. Soil Science Society of America, 10: 429-436.

APPENDIX

SAMPLE

Part of a County Strip-mine- Reconnaissance Map

SCALE: 1 INCH = 1 MILE



LEGEND

Acidity Class	Textural Class		
	SANDY	LOAMS & SILTY SHALES	CLAYS
	Spoil Type Symbol		
TOXIC	TS	TL	TC
MARGINAL	MS	ML	MC
ACID	AS	AL	AC
CALCAREOUS	CS	CL	CC
MIXED	MxS	MxL	MxC

..... OUTCROP NO. 5 COAL SEAM

- - - - - - - OUTCROP NO. 6 COAL SEAM

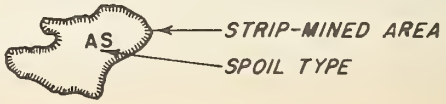


Table 4.--Area of strip-mined land by acidity and texture classes, 1947

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	0	0.0	0	0.0	0	0.0	0	0.0
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	0	.0	0	.0	0	.0
3 Acid. More than 50% with pH of 4.0-6.9	0	.0	2,500	78.9	0	.0	2,500	78.9
4 Calcareous. More than 50% with pH of 7.0 or higher	0	.0	147	4.6	0	.0	147	4.6
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	0	.0	523	16.5	0	.0	523	16.5
Total	0	0.0	3,170	100.0	0	0.0	3,170	100.0

A R K A N S A S

Table 5.--Area of strip-mined land by county and soil texture and acidity class, 1947

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres															Acres
Franklin	0	0	0	0	0	0	0	453	118	501	0	0	0	0	0	1,072
Johnson	0	0	0	0	0	0	0	643	29	0	0	0	0	0	0	672
Logan	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	22
Pope	0	0	0	0	0	0	0	76	0	0	0	0	0	0	0	76
Scott	0	0	0	0	0	0	0	122	0	0	0	0	0	0	0	122
Sebastian	0	0	0	0	0	0	0	1,206	0	0	0	0	0	0	0	1,206
Total	0	0	0	0	0	0	0	2,500	147	523	0	0	0	0	0	3,177

A R K A N S A S

Table 6.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Franklin	233	489	346	4	1,072	9/47
Johnson	335	223	114	0	672	9/47
Logan	4	7	11	0	22	9/47
Pope	50	21	5	0	76	9/47
Scott	111	11	0	0	122	8/47
Sebastian	816	173	217	0	1,206	8/47
Total	1,549	924	693	4	3,170	--

A R K A N S A S

Table 7.--Area of strip-mined land by county and coal seam

County	No. 1, Lower Hartshorne	No. 3, Charleston	No. 4, Paris	Total
	Acres	Acres	Acres	Acres
Franklin	98	974	0	1,072
Johnson	672	0	0	672
Logan	0	0	22	22
Pope	76	0	0	76
Scott	122	0	0	122
Sebastian	1,192	14	0	1,206
Total	2,160	988	22	3,170

Table 8.--Area of strip-mined land by acidity and texture classes, 1946

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	0	0.0	253	0.6	163	0.4	416	1.0
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	362	0.9	173	0.4	535	1.3
3 Acid. More than 50% with pH of 4.0-6.9	0	.0	2,717	6.8	1,323	3.3	4,040	10.1
4 Calcareous. More than 50% with pH of 7.0 or higher	878	2.2	21,754	54.7	8,662	21.8	31,294	78.8
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	1,984	5.0	178	0.4	1,373	3.4	3,535	8.8
Total	2,862	7.2	25,264	63.4	11,694	29.4	39,820	100.0

Table 9.--Area of strip-mined land by county and soil texture and acidity class, 1946

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Bureau	0	0	0	0	0	0	0	0	73	0	0	0	0	0	0	73
Edgar	0	0	0	0	0	0	0	0	246	0	0	0	0	0	0	246
Fulton	0	0	0	0	0	0	0	0	5,928	0	0	173	0	3,7[illegible]	[illegible]	[illegible]
Grundy	0	0	0	785	0	19	251	0	2,024	0	0	0	300	0	0	[illegible]
Henry	0	0	0	0	0	0	0	0	2,198	144	0	0	0	0	0	[illegible]
Hancock	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	200
Jackson	0	0	0	0	0	0	37	0	298	0	0	0	236	111	[illegible]	[illegible]
Knox	0	0	0	0	0	0	0	0	1,605	0	0	0	0	759	0	[illegible]
LaSalle	0	0	0	0	0	0	0	0	0	0	163	0	0	497	0	[illegible]
Perry	0	0	0	0	0	0	0	30	4,958	0	0	0	0	1,527	0	[illegible]
Randolph	0	0	0	0	0	0	0	0	0	0	0	0	0	1,120	0	[illegible]
St. Clair	0	0	0	0	0	0	0	0	1,436	0	0	0	0	0	0	[illegible]
Saline	0	0	0	0	0	24	0	1,926	0	0	0	0	0	0	0	[illegible]
Schuyler	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	[illegible]
Vermilion	0	0	0	0	0	0	0	4	1,538	34	0	0	143	641	277	[illegible]
Will	0	0	0	93	1,984	0	74	0	1,450	0	0	0	0	0	0	[illegible]
Williamson	0	0	0	0	0	210	0	757	0	0	0	0	444	228	204	[illegible]
Total	0	0	0	878	1,984	253	362	2,717	21,754	178	163	173	1,323	8,662	1,373	39,820

ILLINOIS

Table 10.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Bureau	5	1	1	66	73	7/46
Edgar	0	230	16	0	246	8/46
Fulton	3,007	4,167	151	2,567	9,892	7/46
Grundy	1,378	1,764	73	164	3,379	9/46
Henry	370	1,103	196	673	2,342	7/46
Hancock	20	150	30	0	200	7/46
Jackson	470	385	56	624	1,535	5/46
Knox	1,339	291	28	706	2,364	7/46
La Salle	255	380	25	0	660	7/46
Perry	1,548	1,598	317	3,052	6,515	6/46
Randolph	270	253	89	508	1,120	5/46
St. Clair	280	768	101	287	1,436	6/46
Saline	811	876	50	213	1,950	7/46
Schuyler	24	2	1	0	27	7/46
Vermilion	501	1,293	814	29	2,637	9/46
Will	676	2,049	249	627	3,601	7/46
Williamson	1,160	374	38	271	1,843	6/46
Total	12,114	15,684	2,235	9,787	39,820	--

ILLINOIS

Table 11.--Area of strip-mined land by county and coal seam

County	No. 2, La Salle	No. 5, Harrisburg (Springfield)	No. 6, Herrin	Not determined	Total
	Acres	Acres	Acres	Acres	Acres
Bureau	0	0	73	0	73
Edgar	0	0	246	0	246
Fulton	579	3,998	3,518	1,797	9,892
Grundy	2,594	785	0	0	3,379
Henry	1,776	0	0	566	2,342
Hancock	0	0	0	200	200
Jackson	0	298	1,237	0	1,535
Knox	0	0	2,104	260	2,364
La Salle	660	0	0	0	660
Perry	0	758	5,757	0	6,515
Randolph	0	0	1,120	0	1,120
St. Clair	0	0	1,436	0	1,436
Saline	0	1,035	915	0	1,950
Schuyler	0	27	0	0	27
Vermilion	0	0	0	2,637	2,637
Will	3,601	0	0	0	3,601
Williamson	0	1,153	690	0	1,843
Total	9,210	8,054	17,096	5,460	39,820

Table 12.--Area of strip-mined land by acidity and texture classes, 1947

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	595	1.4	241	0.6	0	0.0	836	2.0
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	439	1.1	947	2.2	0	.0	1,386	3.3
3 Acid. More than 50% with pH of 4.0-6.9	576	1.4	30,425	72.8	0	.0	31,001	74.2
4 Calcareous. More than 50% with pH of 7.0 or higher	774	1.9	7,191	16.9	0	.0	7,965	18.8
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	27	0.06	682	1.6	12	0.02	721	1.7
Total	2,411	5.8	39,486	94.2	12	0.02	41,909	100.0

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Table 13.--Area of strip-mined land by county and soil texture and acidity class, 1947

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres					Acres	Acres
Clay	22	0	52	0	0	26	0	5,952	1,257	577	0	0	0	0	12	7,898
Daviess	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	27
Dubois	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	12
Fountain	0	0	0	0	0	46	0	76	83	0	0	0	0	0	0	205
Gibson	0	0	0	0	0	0	0	129	0	0	0	0	0	0	0	129
Greene	0	0	0	0	0	98	0	3,959	1,357	0	0	0	0	0	0	5,414
Knox	0	0	0	0	0	0	0	468	107	0	0	0	0	0	0	575
Owen	0	0	9	0	0	0	0	1,024	24	0	0	0	0	0	0	1,057
Parke	0	0	0	11	0	0	0	18	133	0	0	0	0	0	0	162
Pike	436	83	480	0	0	0	764	8,710	0	0	0	0	0	0	0	10,473
Spencer	0	0	0	0	0	0	0	772	0	0	0	0	0	0	0	772
Sullivan	0	0	0	0	0	3	26	3,831	411	0	0	0	0	0	0	4,271
Vermillion	0	0	0	763	27	0	0	132	304	37	0	0	0	0	0	1,263
Vigo	0	27	35	0	0	56	141	1,439	1,978	0	0	0	0	0	0	3,676
Warrick	137	329	0	0	0	0	16	3,888	1,537	68	0	0	0	0	0	5,975
Total	595	439	576	774	27	241	947	30,425	7,191	682	0	0	0	0	12	41,909

Table 14.--Area of strip-mined land by county and character of vegetation

County	Barren					Herbs				Forested						Total area stripped	Area used as pasture
		Poor Stocking - Trees		Poor Stocking		Fair to Good Stocking				Good Stocking			Fair Stocking				
	No cover	Planted	Volunteer	Herbs 1/	Herbs & 2/ Trees	Weeds & grasses	Legumes	Mixed 3/	Herbs & 4/ Trees	Planted	Volunteer	Planted & Volunteer (Mixed)	Planted	Volunteer	Planted & Volunteer (Mixed)		
	Acres					Acres				Acres			Acres			Acres	Acres
Clay	918	95	73	436	1,642	49	144	373	19	1,644	508	317	362	1,202	116	7,898	101
Daviess	24	0	0	0	0	0	0	0	0	3	0	0	0	0	0	27	0
Dubois	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	12	0
Fountain	96	0	0	0	21	41	0	0	0	44	0	0	0	3	0	205	32
Gibson	0	0	0	0	0	0	0	0	0	129	0	0	0	0	0	129	0
Greene	213	0	0	181	143	37	146	852	54	1,838	332	0	518	1,077	23	5,414	326
Knox	0	81	0	195	0	0	0	0	0	56	0	0	108	28	107	575	0
Owen	115	0	54	0	100	6	83	93	0	117	0	83	0	377	29	1,057	39
Parke	19	0	5	11	0	5	0	0	0	47	23	0	9	43	0	162	11
Pike	2,298	583	55	833	19	34	0	182	0	4,360	518	40	1,298	115	138	10,473	5
Spencer	329	6	0	72	0	0	0	0	69	294	0	0	2	0	0	772	0
Sullivan	426	6	0	33	0	181	363	229	18	1,416	175	265	692	347	120	4,271	227
Vermillion	36	0	0	49	0	54	634	11	27	152	0	87	67	146	0	1,263	0
Vigo	602	122	27	0	250	48	16	62	142	440	46	581	823	517	0	3,676	0
Warrick	706	0	148	189	26	100	0	716	91	3,305	473	0	136	62	23	5,975	72
Total	5,782	893	374	1,999	2,201	555	1,386	2,518	420	13,845	2,075	1,373	4,015	3,917	556	41,909	813
Group Totals			11,249				4,879				17,293			8,488			
											25,781						

1/ Includes weeds, grasses, shrubs and legumes.

2/ Includes poor stocking of planted and volunteer trees with poor stocking of weeds, grasses, and legumes.

3/ Mixture of weeds, grasses and legumes.

4/ Fair to good stocking of weeds, grasses and legumes; poor stocking of planted trees.

I N D I A N A

Table 15.--Area of strip-mined land by county and coal seam

County	Lower Minshall	Block	No. 3	No. 4	No. 5	No. 6	No. 7	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Clay	0	5,942	1,718	0	238	0	0	7,898
Daviess	0	0	0	27	0	0	0	27
Dubois	0	0	0	12	0	0	0	12
Fountain	205	0	0	0	0	0	0	205
Gibson	0	0	0	0	129	0	0	129
Greene	0	138	130	2,524	1,746	544	332	5,414
Knox	0	0	0	0	0	575	0	575
Owen	0	1,057	0	0	0	0	0	1,057
Parke	11	151	0	0	0	0	0	162
Pike	0	0	0	0	10,473	0	0	10,473
Spencer	0	0	0	0	772	0	0	772
Sullivan	0	0	0	0	899	2,553	819	4,271
Vermillion	0	0	0	0	189	1,074	0	1,263
Vigo	0	0	328	848	2,313	187	0	3,676
Warrick	0	0	0	0	5,175	800	0	5,975
Total	216	7,288	2,176	3,411	21,934	5,733	1,151	41,909

Table 16.--Area of strip-mined land by acidity and texture classes, 1947

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	0	0.0	470	18.8	0	0.0	470	18.8
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	251	10.0	0	.0	251	10.0
3 Acid. More than 50% with pH of 4.0-6.9	0	.0	828	33.2	0	.0	828	33.2
4 Calcareous. More than 50% with pH of 7.0 or higher	0	.0	33	1.3	0	.0	33	1.3
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	0	.0	909	36.4	8	0.3	917	36.7
Total	0	0.0	2,491	99.7	8	0.3	2,499	100.0

Table 17.--Area of strip-mined land by county and soil texture and acidity class, 1947

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Davis	0	0	0	0	0	113	37	0	0	0	0	0	0	0	0	150
Mahaska	0	0	0	0	0	212	33	177	0	570	0	0	0	0	0	992
Marion	0	0	0	0	0	65	101	435	33	339	8	0	0	0	0	981
Monroe	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	22
Wapello	0	0	0	0	0	58	80	30	0	0	0	0	0	0	0	168
Warren	0	0	0	0	0	0	0	186	0	0	0	0	0	0	0	186
Total	0	0	0	0	0	470	251	828	33	909	8	0	0	0	0	2,499

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Table 18.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Davis	112	36	2	0	150	8/47
Mahaska	615	321	42	14	992	8/47
Marion	544	370	65	2	981	8/47
Monroe	20	2	0	0	22	8/47
Wapello	147	18	3	0	168	8/47
Warren	65	87	34	0	186	8/47
Total	1,503	834	146	16	2,499	--

Table 19.--Area of strip-mined land by acidity and texture classes, 1946

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	72	0.3	171	0.7	0	0.0	243	1.0
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	97	0.3	0	.0	97	0.3
3 Acid. More than 50% with pH of 4.0-6.9	567	2.3	15,571	61.8	3,319	13.2	19,457	77.3
4 Calcareous. More than 50% with pH of 7.0 or higher	0	.0	1,293	5.1	1,076	4.3	2,369	9.4
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	0	.0	2,624	10.4	392	1.6	3,016	12.0
Total	639	2.6	19,756	78.4	4,787	19.0	25,182	100.0

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Table 20.--Area of strip-mined land by county and soil texture and acidity class, 1946

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres		Acres			Acres	Acres	Acres	Acres	Acres			Acres	Acres	Acres	Acres
Bourbon.	0	0	0	0	0	0	0	688	648	506	0	0	50	0	4	1,876
Cherokee	72	0	220	0	0	55	0	3,829	144	780	0	0	1,724	598	60	7,482
Coffey	0	0	0	0	0	0	0	18	0	0	0	0	82	5	0	105
Crawford	0	0	347	0	0	111	47	10,631	357	921	0	0	789	385	196	13,784
Franklin	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	8
Labette	0	0	0	0	0	5	0	218	0	20	0	0	4	0	0	247
Linn	0	0	0	0	0	0	0	6	144	0	0	0	642	88	91	971
Osage	0	0	0	0	0	0	50	163	0	397	0	0	28	0	41	679
Wilson	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30
Total	72	0	567	0	0	171	97	15,571	1,293	2,624	0	0	3,319	1,076	392	25,182

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Table 21.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Bourbon	360	1,060	456	0	1,876	8/46
Cherokee	3,096	2,338	579	1,469	7,482	7/46
Coffey	17	46	42	0	105	8/46
Crawford	5,968	5,011	1,949	856	13,784	7/46
Franklin	4	3	1	0	8	8/46
Labette	133	82	32	0	247	6/46
Linn	383	501	87	0	971	8/46
Osage	186	297	196	0	679	8/46
Wilson	3	24	3	0	30	9/46
Total	10,150	9,362	3,345	2,325	25,182	--

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Table 22.--Area of strip-mined land by county and coal seam

County	No.1 Riverton	No.3 Columbus	No.4 Rowe	No.6 Weir	No.9 Mineral	No.11 Coalvale	No.12 Croweburg	No.14 Bevier	No.15 Mulky	No.18 Mulberry	No.22 Thayer	No.28 Nodoway	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Bourbon	0	0	0	0	55	0	3	882	896	40	0	0	1,876
Cherokee	6	81	167	2,368	3,589	0	0	1,271	0	0	0	0	7,482
Coffey	0	0	0	0	0	0	0	0	0	0	0	105	105
Crawford	0	0	42	3,151	5,705	13	410	3,985	478	0	0	0	13,784
Franklin	0	0	0	0	0	0	0	0	0	0	0	8	8
Labette	0	0	0	0	86	0	74	87	0	0	0	0	247
Linn	0	0	0	0	0	0	0	0	0	971	0	0	971
Osage	0	0	0	0	0	0	0	0	0	0	0	679	679
Wilson	0	0	0	0	0	0	0	0	0	0	30	0	30
Total	6	81	209	5,519	9,435	13	487	6,225	1,374	1,011	30	792	25,182

Table 23.--Area of strip-mined land by acidity and texture classes, 1947

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	0	0.0	0	0.0	0	0.0	0	0.0
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	1,154	15.9	0	.0	1,154	15.9
3 Acid. More than 50% with pH of 4.0-6.9	22	0.3	6,052	83.3	23	0.3	6,097	83.9
4 Calcareous. More than 50% with pH of 7.0 or higher	0	.0	16	0.2	0	.0	16	0.2
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	0	.0	0	.0	0	.0	0	.0
Total	22	0.3	7,222	99.4	23	0.3	7,267	100.0

Table 24.--Area of strip-mined land by county and soil texture and acidity class, 1947

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres					Acres	Acres	Acres			Acres					Acres
Boyd	0	0	0	0	0	0	319	388	0	0	0	0	0	0	0	707
Christian	0	0	0	0	0	0	0	79	0	0	0	0	0	0	0	79
Hancock	0	0	0	0	0	0	0	99	0	0	0	0	0	0	0	99
Hopkins	0	0	0	0	0	0	596	3,177	0	0	0	0	0	0	0	3,773
Laurel	0	0	0	0	0	0	0	213	0	0	0	0	0	0	0	213
Letcher	0	0	6	0	0	0	0	193	0	0	0	0	0	0	0	199
McLean	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	16
Muhlenberg	0	0	16	0	0	0	149	580	0	0	0	0	0	0	0	745
Ohio	0	0	0	0	0	0	0	306	0	0	0	0	23	0	0	329
Perry	0	0	0	0	0	0	0	217	0	0	0	0	0	0	0	217
Pike	0	0	0	0	0	0	0	171	0	0	0	0	0	0	0	171
Webster	0	0	0	0	0	0	90	295	0	0	0	0	0	0	0	385
Whitley	0	0	0	0	0	0	0	334	0	0	0	0	0	0	0	334
Total	0	0	22	0	0	0	1,154	6,052	16	0	0	0	23	0	0	7,267

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Table 25.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Boyd	707	0	0	0	707	1/48
Christian	24	40	15	0	79	11/47
Hancock	94	4	1	0	99	1/48
Hopkins	2,795	687	270	21	3,773	9/47
Laurel	207	6	0	0	213	1/48
Letcher	197	2	0	0	199	11/47
McLean	11	5	0	0	16	11/47
Muhlenberg	601	64	80	0	745	11/47
Ohio	319	10	0	0	329	11/47
Perry	217	0	0	0	217	1/48
Pike	168	3	0	0	171	8/47
Webster	294	73	18	0	385	9/47
Whitley	290	44	0	0	334	8/47
Total	5,924	938	384	21	7,267	--

Table 26.--Area of strip-mined land by county and coal seam

Eastern Coal Field

County	Lily	Swamp Angel	Elkhorn #1	Elkhorn #2	Elkhorn #3	Upper Freeport	Pittsburgh	Sewickly	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Boyd	0	0	0	0	0	388	319	0	707
Laurel	213	0	0	0	0	0	0	0	213
Letcher	0	0	6	193	0	0	0	0	199
Perry	0	0	0	0	0	0	0	217	217
Pike	0	0	51	0	120	0	0	0	171
Whitley	0	334	0	0	0	0	0	0	334
Total	213	334	57	193	120	388	319	217	1,841

Western Coal Field

County	#6	#9	#11	#11 & 12	#14	Stray Seam	Lewisport	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Christian	79	0	0	0	0	0	0	79
Hancock	0	0	0	0	0	0	99	99
Hopkins	647	1,026	295	936	869	0	0	3,773
McLean	0	16	0	0	0	0	0	16
Muhlenberg	107	381	24	227	6	0	0	745
Ohio	0	306	0	0	0	23	0	329
Webster	0	301	84	0	0	0	0	385
Total	833	2,030	403	1,163	875	23	99	5,426

Table 27.--Area of strip-mined land by acidity and texture classes, 1946

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	168	0.7	304	1.2	476	1.8	948	3.7
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	203	0.8	341	1.3	737	2.9	1,281	5.0
3 Acid. More than 50% with pH of 4.0-6.9	301	1.2	14,356	56.3	333	1.3	14,990	58.8
4 Calcareous. More than 50% with pH of 7.0 or higher	100	0.4	2,261	8.9	1,985	7.8	4,346	17.1
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	42	0.2	3,026	11.8	863	3.4	3,931	15.4
Total	814	3.2	20,288	79.6	4,394	17.2	25,496	100.0

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Table 28.--Area of strip-mined land by county and soil texture and acidity class, 1946

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Barton	14	0	25	0	42	0	135	8,408	0	410	5	0	0	0	0	9,039
Bates	0	0	38	0	0	0	2	1,770	1,989	1,027	0	45	3	0	132	5,006
Boone	0	0	0	0	0	19	73	13	0	0	65	0	0	0	0	170
Callaway	0	0	104	0	0	178	21	9	0	89	343	0	0	7	121	872
Dade	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	90
Henry	0	0	0	0	0	16	73	2,386	25	234	0	38	195	1,446	385	4,798
Howard	0	0	0	0	0	0	0	70	0	0	0	0	0	0	0	70
Jasper	14	0	44	0	0	0	0	54	0	0	0	0	0	0	0	112
Johnson	0	0	0	0	0	1	5	59	41	1	0	0	0	16	150	273
Macon	0	0	0	0	0	0	0	0	180	368	0	0	0	252	0	800
Randolph	26	0	0	100	0	31	0	387	0	477	0	654	0	264	0	1,939
St. Clair	103	0	0	0	0	22	0	0	9	105	0	0	0	0	0	239
Vernon	11	203	0	0	0	37	32	1,200	17	315	63	0	135	0	75	2,088
Total	168	203	301	100	42	304	341	14,356	2,261	3,026	476	737	333	1,985	863	25,496

M I S S O U R I

Table 29.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Barton	2,874	5,334	798	33	9,039	9/46
Bates	2,543	1,537	925	1	5,006	10/46
Boone	157	10	3	0	170	10/46
Callaway	758	75	25	14	872	10/46
Dade	52	37	1	0	90	8/46
Henry	2,443	2,007	346	2	4,798	10/46
Howard	35	28	7	0	70	10/46
Jasper	42	65	5	0	112	8/46
Johnson	207	48	18	0	273	11/46
Macon	160	616	24	0	800	10/46
Randolph	1,374	408	27	130	1,939	10/46
St. Clair	104	77	57	1	239	10/46
Vernon	1,195	598	285	10	2,088	9/46
Total	11,944	10,840	2,521	191	25,496	--

M I S S O U R I

Table 30.--Area of strip-mined land by county and coal seam

County	Nos. 1-5 (Uncorrelated)	No.6 Weir	No.9 Rich Hill	No.10 Fleming	No.11 Coalvale	No.12 Tebo	No.14 Bevier	No.15 Mulky	No.18 Mulberry	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Barton	194	8,480	223	0	0	141	1	0	0	9,039
Bates	2	0	596	55	0	0	0	0	4,353	5,006
Boone	0	0	0	0	0	32	138	0	0	170
Callaway	0	0	0	0	0	0	872	0	0	872
Dade	90	0	0	0	0	0	0	0	0	90
Henry	706	0	2,720	0	0	1,372	0	0	0	4,798
Howard	0	0	0	0	0	0	70	0	0	70
Jasper	112	0	0	0	0	0	0	0	0	112
Johnson	0	0	150	0	0	69	15	39	0	273
Macon	0	0	0	0	0	0	800	0	0	800
Randolph	0	0	0	0	0	0	1,939	0	0	1,939
St. Clair	0	125	0	0	0	114	0	0	0	239
Vernon	22	185	777	71	24	769	21	219	0	2,088
Total	1,126	8,790	4,466	126	24	2,497	3,856	258	4,353	25,496

Table 31.--Area of strip-mined land by acidity and texture classes, 1945-46

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	191	0.5	717	2.0	489	1.4	1,397	3.9
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	883	2.4	1,277	3.6	195	0.5	2,355	6.5
3 Acid. More than 50% with pH of 4.0-6.9	2,181	6.0	12,275	33.9	2,653	7.3	17,109	47.2
4 Calcareous. More than 50% with pH of 7.0 or higher	2	0.1	911	2.5	14,224	39.2	15,137	41.8
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	101	0.2	12	0.1	102	0.3	215	0.6
Total	3,358	9.3	15,192	41.9	17,663	48.8	36,213	100.0

Table 32.--Area of strip-mined land by county and soil texture and acidity class, 1945-46

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Athens	0	193	67	0	0	0	0	296	29	0	0	0	0	0	0	585
Belmont	0	0	0	0	0	0	149	196	0	0	0	75	232	1,153	0	1,805
Carroll	0	0	109	0	0	0	0	807	0	5	0	0	0	0	0	921
Columbiana	46	185	1,201	0	0	25	233	1,727	21	0	0	0	71	0	0	3,509
Coshocton	0	0	19	0	0	0	133	290	0	0	0	0	56	0	0	498
Gallia	0	0	0	0	0	0	0	5	23	0	0	0	0	0	0	28
Guernsey	0	0	0	0	0	0	0	285	0	0	0	0	0	0	0	285
Harrison	0	0	0	0	0	66	0	0	62	0	0	0	80	8,393	30	8,631
Hocking	0	8	97	0	0	166	0	102	0	0	0	0	212	0	0	585
Holmes	0	0	0	0	0	0	0	243	0	0	0	0	0	0	0	243
Jackson	0	0	0	0	0	121	0	104	0	0	0	19	116	0	0	360
Jefferson	0	383	316	0	0	0	91	77	600	0	39	37	71	4,597	41	6,252
Lawrence	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	32
Mahoning	145	12	207	2	75	0	0	0	90	0	41	0	43	0	0	615
Meigs	0	0	0	0	0	0	4	8	0	0	0	0	0	43	0	55
Morgan	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	75
Muskingum	0	0	0	0	0	0	0	1,284	0	0	0	0	0	0	0	1,284
Noble	0	0	0	0	0	0	6	242	28	0	0	0	0	0	0	276
Perry	0	0	47	0	0	172	0	809	0	0	153	47	1,651	0	0	2,879
Portage	0	0	0	0	0	0	158	8	0	0	0	0	0	0	20	186
Stark	0	45	118	0	26	167	224	1,305	0	7	256	17	106	38	11	2,320
Tuscarawas	0	0	0	0	0	0	220	3,749	0	0	0	0	0	0	0	3,969
Vinton	0	57	0	0	0	0	59	623	13	0	0	0	0	0	0	752
Washington	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	8
Wayne	0	0	0	0	0	0	0	0	45	0	0	0	15	0	0	60
Total	191	883	2,181	2	101	717	1,277	12,275	911	12	489	195	2,653	14,224	102	36,213

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Table 33.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Athens	477	64	44	0	585	10/46
Belmont	1,164	617	17	7	1,805	8/47
Carroll	726	180	4	11	921	9/46
Columbiana	2,437	899	93	80	3,509	6/46
Coshocton	493	5	0	0	498	1/47
Gallia	16	10	2	0	28	9/46
Guernsey	167	95	5	18	285	1/47
Harrison	3,233	4,370	225	803	8,631	12/45
Hocking	477	83	25	0	585	12/46
Holmes	194	4	0	45	243	12/46
Jackson	303	15	42	0	360	9/46
Jefferson	3,314	1,754	842	342	6,252	11/45
Lawrence	32	0	0	0	32	9/46
Mahoning	519	95	1	0	615	7/46
Meigs	51	4	0	0	55	9/46
Morgan	74	1	0	0	75	12/46
Muskingum	726	157	131	270	1,284	8/47
Noble	251	25	0	0	276	12/46
Perry	2,014	494	241	130	2,879	12/46
Portage	174	11	1	0	186	7/46
Stark	1,710	548	18	44	2,320	8/46
Tuscarawas	3,377	231	6	355	3,969	12/46
Vinton	660	79	13	0	752	9/46
Washington	8	0	0	0	8	12/46
Wayne	57	3	0	0	60	8/46
Total	22,654	9,744	1,710	2,105	36,213	--

Table 34.--Area of strip-mined land by county and coal seam

County	No. 1 Sharon	No. 2 Quakertown	No. 3a Upper Mercer	No. 4 Brookville	Ogan	No. 4a Clarion	Nos. 5 & 6 (Combined Stripping)	No. 5 Lower Kittanning	No. 5a Strasbourg	No. 6 Middle Kittanning	No. 6a Upper Kittanning	Lower Freeport	No. 7 Upper Freeport	Mahoning	Harlem	No. 8 Pittsburg	No. 8a Redstone	No. 9 Sewickly	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Athens	0	0	0	0	0	0	0	0	0	104	32	0	401	0	0	48	0	0	585
Belmont	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	785	0	1,020	1,805
Carroll	0	0	0	0	0	0	0	416	30	123	0	0	86	261	5	0	0	0	921
Columbiana	0	0	0	0	0	0	0	116	0	0	0	6	2,855	532	0	0	0	0	3,509
Coshocton	0	0	0	0	0	0	0	0	0	498	0	0	0	0	0	0	0	0	498
Gallia	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	23	0	0	28
Guernsey	0	0	0	0	0	0	0	0	0	0	0	0	240	0	0	45	0	0	285
Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,283	0	348	8,631
Hocking	0	0	0	0	0	166	0	0	0	390	0	0	29	0	0	0	0	0	585
Holmes	0	0	0	0	0	0	0	152	0	91	0	0	0	0	0	0	0	0	243
Jackson	26	36	0	0	0	50	0	127	0	0	0	0	121	0	0	0	0	0	360
Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,029	0	223	6,252
Lawrence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	32
Mahoning	0	0	0	0	0	0	0	153	0	264	0	0	198	0	0	0	0	0	615
Meigs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	12	0	55
Morgan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	33	75
Muskingum	0	0	0	0	0	0	0	0	0	1,156	0	0	117	0	0	11	0	0	1,284
Noble	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	269	276
Perry	0	0	0	0	0	0	0	643	0	2,099	0	0	137	0	0	0	0	0	2,879
Portage	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	186
Stark	0	0	8	28	0	0	521	1,136	0	568	0	0	59	0	0	0	0	0	2,320
Tuscarawas	0	0	0	1	0	0	594	3,076	0	225	13	0	60	0	0	0	0	0	3,969
Vinton	0	0	0	14	8	367	0	0	0	156	0	0	207	0	0	0	0	0	752
Washington	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8
Wayne	0	0	0	45	0	0	0	15	0	0	0	0	0	0	0	0	0	0	60
Total	212	36	8	88	8	583	1,115	5,834	30	5,674	45	6	4,515	793	5	15,316	44	1,901	36,213

Table 35.--Area of strip-mined land by acidity and texture classes, 1946

Acidity class	A. Sands		B. Loams and silty shales		C. Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1 Toxic. More than 75% of area with pH less than 4.0	41	0.5	0	0.0	0	0.0	41	0.5
2 Marginal. 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	0	.0	21	0.3	21	0.3
3 Acid. More than 50% with pH of 4.0-6.9	569	6.8	4,314	51.9	2,041	24.5	6,924	83.2
4 Calcareous. More than 50% with pH of 7.0 or higher	0	.0	388	4.7	541	6.5	929	11.2
5 Mixed. Approximately the same proportion of toxic, acid and calcareous areas	0	.0	401	4.8	0	.0	401	4.8
Total	610	7.3	5,103	61.4	2,603	31.3	8,316	100.0

Table 36.--Area of strip-mined land by county and soil texture and acidity class, 1947

County	A. Sands					B. Loams and silty shales					C. Clay					Total
	Acidity class number															
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	Acres		Acres					Acres	Acres	Acres		Acres	Acres	Acres		Acres
Atoka	0	0	0	0	0	0	0	0	0	0	0	0	81	0	0	81
Coal	0	0	0	0	0	0	0	0	0	0	0	0	265	0	0	265
Craig	41	0	0	0	0	0	0	67	116	7	0	21	137	0	0	389
Haskell	0	0	0	0	0	0	0	420	0	0	0	0	504	0	0	924
Latimer	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	14
Mayes	0	0	0	0	0	0	0	94	0	0	0	0	0	0	0	94
Muskogee	0	0	0	0	0	0	0	0	0	0	0	0	474	0	0	474
Okmulgee	0	0	0	0	0	0	0	0	0	0	0	0	149	0	0	149
Pittsburg	0	0	0	0	0	0	0	132	0	0	0	0	28	0	0	160
Rogers	0	0	569	0	0	0	0	971	59	0	0	0	295	0	0	1,894
Tulsa	0	0	0	0	0	0	0	497	213	0	0	0	0	541	0	1,251
Wagoner	0	0	0	0	0	0	0	2,119	0	394	0	0	108	0	0	2,621
Total	41	0	569	0	0	0	0	4,314	388	401	0	21	2,041	541	0	8,316

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Table 37.--Area of strip-mined land by county and character of vegetation

County	Barren	Weeds, grasses, shrubs and legumes	Forested		Total	Date of estimate
			Natural	Planted		
	Acres	Acres	Acres	Acres	Acres	
Atoka	28	50	3	0	81	5/46
Coal	121	133	11	0	265	5/46
Craig	183	184	22	0	389	5/46
Haskell	252	524	106	42	924	5/46
Latimer	2	8	4	0	14	5/46
Mayes	54	11	4	25	94	4/46
Muskogee	285	176	13	0	474	5/46
Okmulgee	62	74	13	0	149	5/46
Pittsburg	72	56	32	0	160	5/46
Rogers	1,284	507	98	5	1,894	4/46
Tulsa	513	466	174	98	1,251	4/46
Wagoner	1,926	570	83	42	2,621	4/46
Total	4,782	2,759	563	212	8,316	--

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Table 38.--Area of strip-mined land by county and coal seam

County	No.2 Upper Hartshorne	No.3 McAlester	No.6 Secor	No.9 Henryetta	No.10 Fleming	No.12 Broken Arrow	No.14 Bevier	No.15 Ft. Scott	No.19 Dawson	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Atoka	81	0	0	0	0	0	0	0	0	81
Coal	0	265	0	0	0	0	0	0	0	265
Craig	0	0	0	74	74	5	1	235	0	389
Haskell	0	924	0	0	0	0	0	0	0	924
Latimer	0	14	0	0	0	0	0	0	0	14
Mayes	0	0	0	0	0	94	0	0	0	94
Muskogee	0	307	167	0	0	0	0	0	0	474
Okmulgee	0	0	0	149	0	0	0	0	0	149
Pittsburg	0	132	28	0	0	0	0	0	0	160
Rogers	1	0	59	0	0	1,229	0	0	605	1,894
Tulsa	0	0	0	0	0	294	0	0	957	1,251
Wagoner	0	0	0	129	0	2,492	0	0	0	2,621
Total	82	1,642	254	352	74	4,114	1	235	1,562	8,316

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